

What Is Claimed Is:

1. A VCSEL having improved diffraction loss,  
comprising:

5 a series of deposited material layers comprising  
the structure of said VCSEL; and

an intracavity lens formed in one of said series  
of deposited material layers.

10 2. A VCSEL according to claim 1 wherein one of  
said series of deposited material layers comprises a  
superlattice structure, with an adjacent region being  
subjected to ion implantation and rapid thermal  
annealing so as to disorder the superlattice structure  
15 and change its index of refraction, whereby to create  
said intracavity lens.

3. A VCSEL according to claim 2 wherein said  
series of deposited material layers comprises:

20 a bottom mirror deposited on the top of a  
substrate;

a bottom spacer deposited on the top of said  
bottom mirror;

a gain region deposited on the top of said bottom spacer;

a top spacer deposited on the top of said gain region; and

a top mirror deposited on the top of said top spacer, such that a reflective cavity is formed between said bottom mirror and said top mirror;

with said intracavity lens being formed in at least one of said bottom mirror, bottom spacer, gain region, top spacer and top mirror.

4. A VCSEL according to claim 3 wherein said substrate comprises a semiconductor material.

5. A VCSEL according to claim 3 wherein said bottom mirror and said top mirror comprise a semiconductor material.

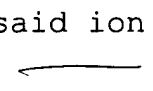
6. A VCSEL according to claim 5 wherein said semiconductor material is chosen from the group consisting of Si, GaAs and InP.

7. A VCSEL according to claim 3 wherein said bottom spacer and said top spacer comprise a semiconductor material.

5 8. A VCSEL according to claim 7 wherein said bottom spacer and said top spacer comprise InP.

10 9. A VCSEL according to claim 3 wherein said gain region comprises a multiple quantum well structure.

15 10. A VCSEL according to claim 9 wherein said gain region comprises a material chosen from the group consisting of InGaAsP and InGaAs.

11. A VCSEL according to claim 9 wherein said ion implantation uses ions selected from the group consisting of phosphorus, oxygen, helium and indium. 

20 12. A method for reducing diffraction loss in a VCSEL structure, said method comprising:  
forming material layers comprising said VCSEL;

with an intracavity lens being formed in one of  
said material layers.

13. A method according to claim 12 wherein one of  
said material layers comprises a superlattice  
structure; and

further comprising subjecting the then-formed  
structure to ion implantation and rapid thermal  
annealing so as to disorder the superlattice structure  
and change its index of refraction, whereby to create  
said intracavity lens.

14. A method according to claim 13 wherein, prior  
to ion implantation, a masking layer is applied to the  
then-formed structure.

15. A method according to claim 14 wherein said  
masking layer has a non-uniform thickness so as to  
create a spatially-varying index in the intracavity  
lens.

16. A method according to claim 14 wherein,  
subsequent to ion implantation and prior to annealing,  
said masking layer is replaced by a proximity cap.

5           17. A method according to claim 13 wherein  
forming said material layers comprises:

- 10           (a) providing a substrate;
- (b) forming a bottom mirror on the top surface of  
said substrate;
- (c) forming a bottom spacer on the top surface of  
said bottom mirror;
- (d) forming a gain region on the top surface of  
said bottom spacer;
- 15           (e) forming a top spacer on the top surface of  
said gain region; and
- (f) forming a top mirror on the top surface of  
said top spacer, such that a reflective cavity is  
formed between said bottom mirror and said top mirror.

20           18. A method according to claim 17 wherein said  
substrate comprises a semiconductor material.

19. A method according to claim 17 wherein said bottom mirror and said top mirror comprise a semiconductor material.

5           20. A method according to claim 19 wherein said semiconductor material is chosen from the group consisting of Si, GaAs and InP.

10           21. A method according to claim 17 wherein said bottom spacer and said top spacer comprise a semiconductor material.

15           22. A method according to claim 21 wherein said bottom spacer and said top spacer comprise InP.

20           23. A method according to claim 17 wherein said gain region comprises a multiple quantum well structure.

20           24. A VCSEL according to claim 23 wherein said gain region comprises a material chosen from the group consisting of InGaAsP and InGaAs.

25. A method according to claim 23 wherein said ion implantation uses ions selected from the group consisting of phosphorus, oxygen, helium and indium.